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FIRST RESULTS OF A RADIOASTRONOMICAL OBSERVATION OF AN ANNULAR SOLAR ECLIPSE

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FIRST RESULTS OF RADIOASTRONOMICAL OBSERVATION OF AN ANNULAR SOLAR ECLIPSE [Russian title] *

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Radioastronomical observations of solar eclipses allow a break down of radiation of separate parts in the Sun, situated at distances of a few angular seconds from one another. It would take telescopes of 1 km dimensions to obtain an equivalent resolving power, which is still unattainable. Therefore, the content of fundamental measurements carried out during eclipses by radiometers is linked with problems that cannot be solved by usual means. To such problems are related: the determination of dimensions, of brightness temperature and of that of local distribution of emission spectra above sunspot groups, the determination of Sun's radiodiameter, the investigation of radiobrightness distribution about the solar disk, and more particularly its increase toward the limb.

Beginning with 1947, eclipse observations with the aid of radiometers were conducted as far as possible in all cases, when the eclipse band was accessible to expeditions. Soviet scientists used radioastronomical methods during observations of seven eclipses — in 1947, 1952, 1954, 1956, 1958, 1961 and 1962. Among the results obtained we must first of all mention the determination of precise dimensions of emission sources situated above sunspot groups, the revelation of a significant increase in the dimensions

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* [PERVYYE REZUL'TATY RADIONABLYUDENIY KOL'TSEOBRAZNOGO ZATMENIYA SOLNTSA.]

of the emission source at passing from the centimeter to the decimeter band, construction of separate sources' emission spectra and the determination of radiobrightness temperature variation in the solar limb.

The last two problems were raised also during the observations of the annular eclipse of 31 July 1962 in Mali, where a special astronomical expedition of the USSR Academy of Sciences was posted. To these problems, measurements of Sun's ellipticity by scanning methods, and observations of atmosphere's and hydrometeors' proper radiofrequency radiation have been added.

The Mali expedition disposed of three radiotelescopes operating in 2, 3.2 and 4.5 cm wavelengths. The eclipse observations were conducted in 3.2 and 4.5 cm wavelengths, and those of atmosphere radiation — in 2 and 3.2 cm.

The eclipse started at 10 h. 18 min, 08 sec local time. The annular phase lasted 3 minutes 32.6 seconds (from 12 h 14 m 8.6 sec to 12 hrs 17 min. 41.2 sec). The eclipse ended at 14 h 14 m. 11.2 sec. All the proposed program was successfully completed and some preliminary results of processing of the recordings obtained can already be presented.

Observations in the 4.5 cm wavelength, carried out in a radiotelescope of 3 meters in diameter, have shown that the emission source from the place where a sunspot group disintegrated on the previous day (No.113 according to "Solar Data") created a flux roughly equal to 1.5% of the "unperturbed" Sun's flux. The remainder of the emission flux at time of annular phase constituted 17% of the "unperturbed" Sun's flux.

The observation recordings in the 3.2 cm wavelength, carried out by means of an analogus radiotelescope but with an additional device for scanning the antenna pattern, have shown the following:

the above-indicated source's share of emission constituted 1.8%, the remaining flux being near 11%.

The natural emission of cumulus clouds in the Bamako region during the rainy season has shown that its effective temperature reached in certain cases to 120° K.

Comparison of the obtained preliminary results with the observations material of 19 April 1958 and 15 February 1961 eclipses led to a series of conclusions.

First of all the emission spectrum in the $3.2\ \text{cm} < \lambda < 4.5\ \text{cm}$ band resulted notably flatter than the spectra obtained earlier for sources connected with large sunspot groups. This is evidence of considerably lesser magnitude of its magnetic field. Quite interesting is also the circumstance that no sunspots existed at that point on the day of observation. The existing sunspot group in that place on previous days was little active and its surface did not exceed 90 millionths of the visible Sun's hemisphere. Upon computation of the magnetic field intensity in the source from the observation data this result was precious for the currently undertaken attempts to clarify the mechanism of increased Sun's radio emission.

It has been further established that the bright limb in the Sun's disk at $\lambda = 4.5$ cm ends in the region $0.939 < r/R_{\odot} < 0.972$ ($R_{\odot}$ being the radius of Sun's photosphere).

Finally, the Sun's ellipticity at $\lambda = 3.2$ cm., which appeared in 1958 as being smaller than the magnitude accessible to measurements (ellipse's semiaxes ratio is 1.1), was clearly registered for $\lambda = 3.2$ cm during the described observations. This result allows to estimate quantitatively the degree of Sun's corona influence upon the lower layers of its atmosphere, whose smallness in the cm wave band rendered the ellipticity observation particularly difficult.

More detailed conclusions will require painstaking efforts in processing the results and will be published as completed.

Astrometric observations entered also the work program of the expedition. Such observations allow to determine the moments of visible Sun's and Moon's disk contacts, which may be utilized for determining the corrections of Moon's coordinates relative to the Sun. In processing these observations, carried out more than once during eclipses, difficulties arise, which are linked with the taking into account of lunar limb unevennesses, and the differenciation of Moon's shape from a sphere.

The processing of Moon's position observation against the background of surrounding stars is beset with the same difficulties. Such observations have however been the object of wide expansion during the latest years. Should it suffice to say that nearly 25 observatories in the USSR and abroad regularly photograph the Moon with the view of studying the irregularities of Earth's rotation and determining the ephemeris time. Measurements of Moon's disk with the view of determining its shape are not carried out at this time, for it is impossible to reliably judge about the shape of the Moon as a whole from a "damaged" disk.

To solve this problem Kh. I. Pooter and N. F. Bystrov offered to photograph the disk of the Moon during annular solar eclipses and near topocentric Full Moons.

This problem is quite strictly resolved from the photographs during annular Sun's eclipses, while the moments of topocentric Full Moons must necessarily by so chosen that the width of the "damaged" part be neglectingly small, and that no lunar eclipse take place. Because of insignificant Moon's shape deflection from the sphere (according to A. A. Yakovin the thickness of the complementary layer $a = 0.81$) photographing should be made with the aid of long-focus instruments.

For the completion of astrometric observations program the expedition disposed of a refractor with a focal distance of 6 m and

objective's diameter of 20 cm. The moments of photographing were fixed on the printing chronograph's tape. Astronomical determinations of observation points' coordinates were made with the help of a 5-second universal aero-geodevice.

In spite of unfavorable weather conditions on the day of eclipse, 17 photographs of partial phases of eclipse were obtained at clearing moments between passing clouds. These photographs will serve to determine the moments of contact, and an attempt will be made to investigate the unevenness of the lunar limb and that of Moon's shape.

***** THE END ******

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